

## Claims:

1. A gas pressure regulator comprising:  
an electrochemical cell including a first electrode for decomposing gas into ions, a second electrode for converting the ions generated in the first electrode into the gas again and an ion conductor sandwiched in between both the electrodes;  
and  
a high pressure vessel disposed in one side of the electrochemical cell.
2. The gas pressure regulator according to claim 1, further comprising means for supplying control current to both the ends of the first electrode and the second electrode, wherein a quantity of the control current is controlled to control the flow rate of gas flowing across both the electrodes.
3. The gas pressure regulator according to claim 1, wherein the gas is hydrogen gas or oxygen gas.
4. The gas pressure regulator according to claim 1, wherein the ion conductor is a film made of an electrolyte material capable of permeating the ionized gas.
5. The gas pressure regulator according to claim 1, wherein the first electrode and the second electrode are electrode films on which a catalyst capable of ionic equilibrium of the gas is carried.
6. The gas pressure regulator according to claim 1, wherein a low pressure vessel is disposed in the other side of the electrochemical cell, the electrochemical

cell serves as a gas partition wall and has a means for regulating pressure by controlling a potential between both the electrodes when a pressure difference is generated between both the sides of the electrochemical cell.

7. The gas pressure regulator according to claim 6, wherein electromotive force generated from the pressure difference is short-circuited or the pressure is regulated by a variable resistor.

8. The gas pressure regulator according to claim 1, wherein a plurality of electrochemical cells are arranged in parallel in a gas flowing direction and has a multistage structure.

9. The gas pressure regulator according to claim 1, wherein when both the sides of the electrochemical cell serving as the gas partition wall have closed vessels, when one side serves as a high pressure gas tank and the other side is connected to a gas consuming system, a pressure sensor is disposed in the closed vessel in the other side and the pressure sensor interlocks with a relay switch connected between both the electrodes of the electrochemical cell to function to compensate for the consumption of gas.

10. The gas pressure regulator according to claim 1, wherein the electrochemical cell functions as a gas refining filter.

11. The gas pressure regulator according to claim 1, wherein the ion conductor is a proton conductor, the proton conductor is formed with a derivative by introducing a proton dissociation group to carbon atoms forming a material

which has, as a main component, at least a kind of material selected from a group including fullerene molecules, a cluster having carbons as a main component and a structural body having tubular or linear carbons, and the proton generated in the first electrode is moved to the second electrode through the proton conductor.

12. The gas pressure regulator according to claim 11, wherein the proton dissociation group is  $-XH$  (X indicates an arbitrary atom or an atomic group having bivalent bonds and H indicates a hydrogen atom.).

13. The gas pressure regulator according to claim 12, wherein the proton dissociation group is  $-OH$  or  $-YOH$  (Y indicates an arbitrary atom or an atom group having bivalent bonds.).

14. The gas pressure regulator according to claim 13, wherein the proton dissociation group is a group selected from any of  $-OH$ ,  $-OSO_3H$ ,  $-COOH$ ,  $-SO_3H$ ,  $-OPO(OH)_2$ , and  $-C_6H_4-SO_3H$ .

15. The gas pressure regulator according to claim 11, wherein the fullerene molecules are spherical shell type carbon cluster molecules  $C_m$  (m indicates a natural number in which  $C_m$  may form a spherical shell structure.).

16. An electrochemical device comprising:

an electrochemical cell including a first electrode for decomposing hydrogen gas into protons, a second electrode for converting the protons generated in the first electrode into the hydrogen gas again and a proton conductor sandwiched in between both the electrodes;

a high pressure vessel disposed in the first electrode side of the electrochemical cell to accommodate a gaseous material including the hydrogen gas; and

a gas consuming part including a pressure reducing part in which the electrochemical cell functions to reduce pressure in the high pressure vessel, a hydrogen gas storage part disposed in contact with the second electrode side in the pressure reducing part, a third electrode disposed in contact with the hydrogen storage part to decompose the hydrogen gas supplied from the hydrogen gas storage part into protons; a fourth electrode for converting the protons generated in the third electrode into water, and a proton conductor sandwiched in between both the electrodes; the protons being converted into water in the fourth electrode to take out electrochemical energy between the third electrode and the fourth electrode.

17. Then electrochemical device according to claim 16, wherein oxygen gas or oxygen containing gas is supplied to a surface of the fourth electrode that does not come into contact with the proton conductor to react with the protons passing through the proton conductor and convert the protons into water, and the electrochemical energy is taken out between the third electrode and the fourth electrode.

18. A gas storage device comprising:

a gas inlet and outlet part for introducing or discharging gas;

a gas storage part for storing gas; and

an electrochemical cell disposed in the gas storage part and including a first electrode for decomposing the gas into ions, a second electrode for converting the ions generated in the first electrode into the gas again and an ion conductor sandwiched in between both the electrodes; wherein the gas is supplied to or discharged from the gas storage part through the gas inlet and outlet part in accordance with the function of the electrochemical cell to decrease or increase pressure in the gas storage part.

19. The gas storage device according to claim 18, further comprising: a gas storage assist system, the gas storage assist system including:

a gas passage for supplying the gas to the gas inlet and outlet part provided in the gas storage device;

a pressure detecting means for detecting gas pressure in the gas passage;

a voltage detecting means for detecting voltage generated between the first electrode and the second electrode;

a calculating means for calculating a control current signal on the basis of the gas pressure and the voltage;

a current supply means for generating a control current; and

a switching means for alternately switching a state that the control current is supplied between the first electrode and the second electrode and a state that the voltage is detected until the voltage reaches a predetermined value.

20. A gas pressure regulating method comprising:
- a decomposing step of decomposing gas into ions in a first electrode;
  - a conducting step of conducting the decomposed ions to a second electrode side through an ion conductor sandwiched in between the first electrode and the second electrode; and
  - a converting step of converting the conducted ions to the gas again in the second electrode.
21. The gas pressure regulating method according to claim 20, wherein a control current is supplied to both the ends of the first electrode and the second electrode to control a quantity of the control current so that the flow rate of gas flowing across both the electrodes.
22. The gas pressure regulating method according to claim 20, wherein an electrochemical cell including the first electrode, the second electrode and the ion conductor serves as a gas partition wall and when a pressure difference is generated at both the sides of the electrochemical cell, a potential between both the electrodes is controlled to regulate the pressure.
23. The gas pressure regulating method according to claim 22, wherein electromotive force generated from the pressure difference is short-circuited or the pressure is regulated by a variable resistor.
24. The gas pressure regulating method according to claim 22, wherein when a high pressure gas storage tank is disposed at one side of the electrochemical cell

serving as the gas partition wall and a closed vessel connected to a gas consuming system is disposed at the other side, a pressure sensor is disposed in the closed vessel in the other side and the pressure sensor interlocks with a relay switch connected between both the electrodes of the electrochemical cell to function to compensate for the consumption of gas.